

reeds are approximately $\frac{1}{4}$ inch wide, 2 inches in length and the brass leaf 34 has a thickness as of 0.001 to 0.002 inch and piezoelectric layers 32 and 33 have thicknesses as of 0.007 to 0.008 inch. The conductive layer 35 has a thickness, as of 50 micro inches. Such reeds are commercially available from NGK of Nagoya, Japan as model MT-114H bimorphous elements.

The reeds utilized herein are electrically polarized for parallel operation at the factory by the application of a high voltage across conductive layers 35. A polarization mark 36 indicates the positive terminal during the polarizing process.

The operating potentials are applied to the respective reeds 17 by means of a circuit schematically indicated in FIG. 4. More particularly, a source of relatively high voltage, as of +160 volts is applied to terminal 37 which is connected to the upper layer 35 of the bimorphous piezoelectric reed 17. The central leaf 34 is connected to one terminal of a double pole-double throw switch 38 which is preferably a transistor switch. The lower face electrode 35 of the reed 17 is connected to ground. The switch 38 selectively couples the central leaf 34 either to the high positive potential or to ground potential which either places the full 160 volts across the lower piezoelectric layer 33, or across the upper piezoelectric layer 32 as determined by the position of switch 38.

When positive potential is applied across the upper piezoelectric layer 32, it deflects the reed upwardly about the fulcrum 18 and conversely when the positive potential is applied across the lower piezoelectric layer 33, it deflects the reed 17 downwardly about the fulcrum 18. The bending moment selectively applied to the reed causes the sensing rod 26 associated with that reed to be either fully elevated as determined by the shoulder of the rod being stopped by the marginal edge of the respective bore 24 in the sensing plate 19 or conversely when the bending moment is downward, the reed deflects downward and gravity operating on the respective sensing rod 26 causes the rod to be fully retracted so that the degree to which the sensing rod protrudes, if any, from the sensing surface 23 is greatly reduced relative to the amount of protrusion when the rod is fully elevated. The operator senses the pattern of protruding rods 26 to define a given braille character.

In the schematic diagram of FIG. 4, the switch 38 is closed to the grounded terminal for elevating the sensing rod 26. The switch 38 is closed to ground by means of an electrical solenoid 41 magnetically operating on a magnetically permeable core member 42 mechanically coupled via rod 43 to the switch 38. Current is fed to the solenoid 41 from a battery 44 via the intermediary of a switch 45 and an interrupter 46. A compression spring 47 is coupled to the core member 42 and spring biases the switch 38 to the high voltage terminal 37 for holding the sensing rod 26 in the normally retracted position.

To raise the sensing rod 26 for indicating to the reader one element of a braille character, the switch 45 is closed thus energizing the solenoid 41 and pulling the core 42 and switch actuating rod 43 against the spring bias of spring 47. In this manner, switch 38 is closed to the ground position, placing the positive voltage across the upper piezoelectric layer 32, for raising the sensing rod 26.

To indicate additional information, such as the case of the braille character being displayed, the interrupter 46 on one or more of the cell elements is energized via an

input to the interrupter at 48. This will interrupt the current to the solenoid at a desired repetition rate and produce vibration of the respective sensing rod 26. The braille reader senses the vibration and thus receives the additional information, such as upper or lower case of the braille character being read by the reader. This additional information is imparted to the braille reader without having to use a second braille cell and without having to add additional sensing rods 26 to the standard six rod electromechanical braille cell 11.

Although the embodiment of FIG. 4 is depicted using a mechanical switch 38, an alternative preferred embodiment would use a transistor switch in its place. Such a transistor switch is readily electronically modulated in a conventional manner to produce vibration of the sensing rod 26.

Also, vibration of all of the sensing rods of a braille character need not be employed to indicate the additional information. As an alternative, one or more of the sensing rods 26 could be vibrated to input the additional information.

Electrical connection is made to the root ends of the respective reeds by means of a printed circuit board, mating with the recessed web 15 not shown and leads which connect the circuit on the printed circuit board to the respective terminals of each of the respective reeds 17 in a manner as indicated in FIG. 4.

In a typical example, the sensing rod 26 is made of ABS plastic, has a diameter of 0.082 inch and a length for the neck portion 25 of 0.328 inch. The rods are conveniently made by injection molding and their length from the shoulder to the base varies from 0.095 inch to 0.845 inch.

An advantage to the manner in which the electrical potentials are applied to the reeds 17 as shown in FIG. 4 is that the piezoelectric layers 32 and 33 are permanently electrically polarized in the same sense as that of the applied operating electric field. More particularly, the electric vector of layer 32 is perpendicular to and directed toward the plane of the central leaf 34, whereas the permanent electric polarization vector of the lower piezoelectric layer 33 is normal to the leaf 34 and directed away from the leaf. The applied voltage for actuation of the reed 17 is thus always applied in the direction of the electric field polarization of the layers 32 and 33. In this manner, depolarization of the reeds with usage does not occur.

The inner ends of the respective top plates 19 are recessed at 39 for mounting to a stringer, not shown, extending laterally of the individual electromechanical braille cells 11. The recessed portion 39 includes a vertical bore 41 to receive a screw passing into a tapped bore in the stringer. Similarly, a tapped bore 42 is provided in the centrally recessed portion 21 of the top plate to receive a screw passing through the central stringer and threadably mating with the threads of the bore 42.

By cantilevering the reeds 17, the braille cells 11 may be arranged in a pair of rows, as shown in FIG. 6, thereby providing two relatively closely spaced lines of braille text.

What is claimed is:

1. In a method for operating an electromechanical braille cell of the type having a braille reading surface intersected by a plurality of openings therein with a plurality of rods operative within said openings and said rods being elevated in a predetermined pattern above said braille reading surface for sensing by the fingers of